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APPENDIX A

Bioemissions Monitoring of Medical Waste Treatment Technologies: A Review of the Literature

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ABSTRACT

The Medical Waste Tracking Act of 1988 required the Environmental Protection Agency (EPA) to identify alternative (or non-regulatory) approaches to the management of medical waste. Such treatment systems have yet to be effectively evaluated to assess their potential for biological emissions and possible associated environmental and occupational public health risks. A literature review was thus conducted regarding biological emissions from various medical waste treatment processes. This report summarizes available information, knowledge gaps, and research needs regarding bioemission test organisms, monitoring methods, and various medical waste treatment technologies to include incineration, steam autoclaving, mechanical/chemical, and microwave processes.

Bioemissions monitoring during medical waste incineration has been conducted using impingers, filters, and slit-to-agar samplers. Recovered organisms included bacterial endospores and vegetative bacteria from both spiked and non-spiked wastes. Spores of *Bacillus stearothermophilus* and *Bacillus subtilis* were used as indicator organisms introduced into the waste prior to processing.

While *B. stearothermophilus* spores are used to routinely monitor steam sterilization, data on high vacuum sterilizer bioemissions were generated using *B. subtilis* spores, gram-negative bacteria, and T1 bacteriophage (virus). All-glass impingers (AGI-30) and sieve impactor samplers successfully recovered the organisms from the exhaust air prior to steam pressurization, and at intervals throughout evacuation.

Two studies of a flow-through mechanical/chemical treatment system used waste spiked with *Serratia marcescens* as an indicator organism. Aerosol monitoring with AGI-30 impingers and sieve impactor showed no airborne organisms when the machine was operated with the treatment chemical. There are no reports in the literature of bioemissions monitoring during microwave processing of medical waste.

B. stearothermophilus and *B. subtilis* var. *niger* spores are standard sterilization indicators for moist and dry heat inactivation respectively, and are also intrinsically resistant to chemical inactivation. *B. stearothermophilus* is not commonly found in medical waste, and can be isolated selectively due to its thermophilic growth property. *B. subtilis* var. *niger* produces a distinctive pigmentation which can help differentiate it from other *Bacillus* species. Spores of both organisms are recommended for medical waste bioemissions monitoring studies.

All-glass impingers, sieve impactors, and slit-to-agar samplers are recognized as commonly used bioaerosol samplers, and have been successfully used to monitor airborne microorganisms from a variety of processes. Additionally, they are required for procedures such as the ASTM Standard Practice for Sampling Airborne Microorganisms at Municipal Solid-Waste Processing Facilities, and the National Sanitation Foundation's Standard Number 49, Class II Biohazard Cabinetry.